AD-A067 141 FOREIGN TECHNOLOGY DIV WRIGHT-PATTERSON AFB OHIO F/G 22/2

SATELLITE NOSE FAIRING,(U)

NOV 78 C TENG

UNCLASSIFIED FTD-ID(RS)T-1644-78 NL

| OF |

AD
A067 141

END
DATE
FILMED
6--79
DDC

FTD-ID(RS)T-1644-78

1

FOREIGN TECHNOLOGY DIVISION

AIR FORCE SYSTEMS COMMAND

SATELLITE NOSE FAIRING

By

Chi Teng

FOREIGN TECHNOLOGY DIVISION

Approved for public release;
distribution unlimited.

EDITED TRANSLATION

FTD-ID(RS)T-1644-78 24 November 1978

MICROFICHE NR: FTD-78-C-001585

SATELLITE NOSE FAIRING

By: Chi Teng

English pages: 7

Source: Hang K'ung Chih Shih, Nr. 2, 1978, pp. 20-21

Country of Origin: China
Translated by: SCITRAN
F33657-78-D-0619
Requester: USAMIRADCOM

PREPARED BY:

TRANSLATION DIVISION
FOREIGN TECHNOLOGY DIVISION
WP-AFB, OHIO.

SATELLITE NOSE FAIRING

Chi Teng

Abstract

Satellite nose fairing is one constituent of the carrier, and although not very complicated, its safe and reliable operation is indispensible to a successful launching. This article is a discussion of the nose fairing's function, separation mechanism, choice of material and its profile determination.

*   *   *

In outer space, there are satellites of all different sizes, shapes and functions. When these satellites are launched, most of them are covered with a nose fairing to protect them from severe aerodynamic pressure and heating in their ascents. After they are above the dense atmosphere, the nose fairing is jettisoned from the carrier rocket to reduce the load and conserve energy. In the jettison process, explosion fragments and contaminating gas should be contained and the disturbance due to separation kept at a minimum. Since the successful launching of a satellite relies on the protection and the separation of the nose fairing, both must be guaranteed to be highly reliable. Therefore, the nose fairing, seemingly a simple device, must meet the requirements on both the aerodynamic profile and a responsive and reliable separation mechanism. Extensive ground testings are needed to ensure the flight's success. In general, the protection structure is easier to design than the separation structure. As a matter of fact, the design of the

separation mechanism has become the main concern of the nose fairing.

Modes of Separation

Generally, there are two methods to jettison the nose fairing. The first method is the overhead separation, that is the fairing is pushed out to the front of the satellite. In removing the cap of a fountain pen, the cap must move forward along the axis of the pen and any tilting would cause it to rub against the pen tip. In the short moment after the separation, with the nose fairing in the vicinity of the satellite and the carrier, there remains the danger of a collision. Therefore, either the fairing or the carrier would have to take a dynamic movement in order to create a distance between them. This brings up some control problems to the separation.

When the separation takes place with both the fairing and the carrier undergoing acceleration, the overhead jettison would require relatively large separation and control forces to avoid collision. Under such circumstances, the jettison is often delayed until the carrier engine is turned off and the acceleration drops down to zero in order to avoid collision. As a result, the carrier vehicle would have to spend extra energy in the acceleration of the fairing. The advantage of this method is a simple unibody structure of relatively light weight, suitable for early models of small satellites.

The second separation method is the pedal style where the fairing separates into two halves along its longitudinal axis much like the two halves of a clam shell. The two half shells are held together with an explosive bolt or quill with the base of the pedals hinged on the carrier vehicle and fixed with explosive bolts along its circumference.

To separate, the bolt or quill is exploded to open the locking mechanism, and under the influence of the separating force (due to spring, powder or small gas nozzle) the two pedals will rotate around their hinge to a certain angle where the hinge connectors disengage and the fairings are thrown out by its own rotational inertia. Almost all large satellites and space explorers are equipped with this type of nose fairing, see Fig. 1.

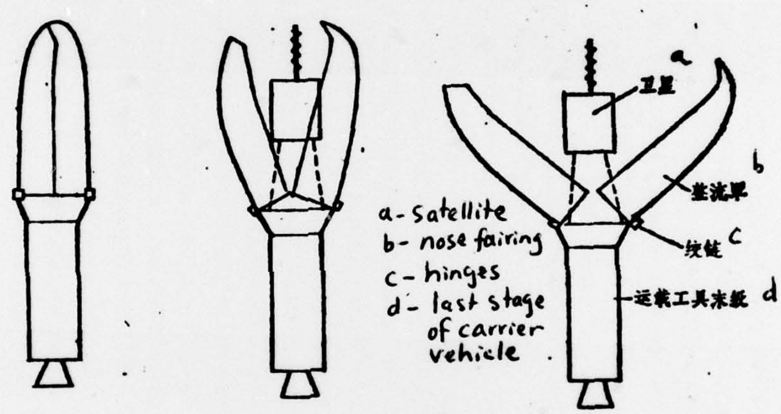

Fig. 1 Schematic diagram showing the three stages of the pedal-type separation: 1. Bolt (or quill) explodes, unlock; 2. Pedals rotate under separating force; 3. Rotation continues until hinges disengage.

Selection of Material

Aluminum alloy and magnesium alloy are widely used as nose fairing mater~~e~~ials. Magnesium frame has good high temperature properties but requires complex heat treatment. Aluminium alloy is easier to form although both alloys are heavier than glass steel. At one time there

seemed to be a tendency that glass steel will replace aluminium and magnesium alloys. After the new technique of chemical or mechanical milling of grilled tile, excessive weight of metal fairings can be easily milled away, aluminium and magensium alloys are coming back again.

The mechanical properties of glass steel are close to those of magnesium alloy, which makes it a good light structure material and its forming procedure is relatively simple. Glass cloth soaked with organic resin is first laid on the mold in a vacuum bag. The resin is then hardened by heating it to form the shell body. The thickness is easily controlled by laying different numbers of glass cloth, a distinct advantage of form glass steel. In addition, since the resin reflects negligible amounts of electromagnetic waves, no windows need to be opened on the nose fairing for the passage of waves. One shortcoming of the glass steel is that, at temperatures over 100° C, the yellow residue from the evaporated resin may contaminate the satellite. Although the precipitation of the evaporated resin is relatively slow, this material is often ruled out on satellites requiring strictly contamination free. In any case, the good heat resistance of the glass steel makes it a suitable material for heat protection of the nose cone.

The honeycomb triplex structured glass steel has been used in satellite nose fairing since it has relatively large rigidity and strength to weight ratios. However, there are still some problems to be solved. The major fault is that the honeycomb cannot always be firmly attached, and separation between layers may occur. Another problem is to get rid of the air trapped in the honeycomb spaces between the sandwiching layers of glass cloth. The overhead jettison type nose fairing on the early interstellar explorer "Mariner" has this honeycomb layered structure.

The trapped air did cause one flight to fail: signals from the remote monitor indicated that the Mariner did not get rid of its nose cap after the fairing separation command was transmitted. What caused this failure? It turns out that, when the satellite was on the ground, the pressure of the trapped air was equal to the exterior atmospheric pressure. The exterior pressure dropped rapidly as the carrier rocket was climbing and the trapped air pressure soon exceeded the ourside pressure and the expanding air ripped off the glass cloth, which happened to tangle with the satellite. Thus, after loosening the release spring, the fairing only moved forward slightly before it got caught and the separation failed.

Peculiar Profile

The profile or early Mariner nose cone has a sharp and smooth tip which reduces shockwaves by attenuating the aerodynamic pressure smoothly. But not many nose fairings have good streamlined profiles since the size and shape of the fairing are largely determined by the size and shape of the satellite. For example, if the cross section of the satellite is larger than that of the last stage carrier rocket, the satellite may have a peculiar plummet or light bulb shaped nose fairing. With this kind of profile, there will obviously be serious aerodynamic vibration problems if the fairing is not made correctly. Hence, extensive wind tunnel experiments are required in determining the geometric parameters of the profile. Fig. 2 shows several external shapes of nose fairings.

In determining the nose cone shape, considerations are often given to the requirements of the satellite and the heat resistant characteristics of the material used. The light bulb shape nose cone may reach a

Fig. 2 Several different shpaes of nose fairings. Left: overhead fairing; right: clam shell type fairing.

temperature as high as 1000^{o} C at its tip, glass steel or other heat resistant materials are used in making the cone. Obtuse nose cones have greater surface area at their front end, aerodynamic heating will therefore raise a greater area to a high temperature. Pointed nose cones may reach a higher temperature but the heating is more localized. Narrow and pointed cones also increase the length of the cone and reduce the usable space in the cone.

Simulation Tests on the Ground

People have learned from the experience of designing and producing satellite nose fairings that separation tests must be carrier out under simulated high altitude conditions to ensure safe and reliable jettison in space. One example is the "Aber" carrier vehicle's pedal type

nose fairing. The two half conic shells are designed to be activated by springs and to rotate around the base before they are thrown out. Although the design passed ground tests, remote data showed malfunction and jettison failure. After extensive experiments, the source of malfunction was located. Since the tests were performed under atmospheric pressure, the interior and exterior pressures of the cone are equal and the atmosphere also exerts damping effect on the rotating pedals. At high altitude, however, the extremely thin air exerts no damping effect, and as a result, the unimpeded impact locally deformed and jammed the structure, and prevented the shells from separation. This episode testifies to the importance of the simulation tests. Only after a series of simulation tests on the ground to verify the performances of the nose fairing and its separation mechanism, can a successful flight be ensured.

Figures by Yen Ho

DISTRIBUTION LIST

DISTRIBUTION DIRECT TO RECIPIENT

ORGANIZATION	MICROFICHE	ORGANIZATION	MICROFICHE
A205 DMATC	1	E053 AF/INAKA	1
A210 DMAAC	2	E017 AF/RDXTR-W	1
B344 DIA/RDS-3C	9	E403 AFSC/INA	1
C043 USAMIIA	1	E404 AEDC	1
C509 BALLISTIC RES LABS	1	E408 AFWL	1
C510 AIR MOBILITY R&D LAB/FIO	1	E410 ADTC	1
C513 PICATINNY ARSENAL	1	FTD	
C535 AVIATION SYS COMD	1	CCN	1
C591 FSTC	5	ASD/FTD/NIIS	3
C619 MIA REDSTONE	1	NIA/PHS	1
D008 NISC	1	NIIS	2
H300 USAICE (USAREUR)	1		
P005 DOE	1		
P050 CIA/CRB/ADD/SD	1		
NAVORDSTA (50L)	1		
NASA/KSI	1		
AFIT/LD	1		
LLL/Code L-389	1		